Journal of Orthopaedic Translation (2016) 7, 114—115

Available online at www.sciencedirect.com

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Session: Total Joint Replacement

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RAMAN SPECTROSCOPIC ANALYSES OF CRYSTALLINITY AND STRAIN COMPARING UNUSED AND RETRIEVED UHMWPE TIBIAL INSERTS STERILIZED BY BETA IRRADIATION

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Introduction: Since its first introduction in the late 1960s, ultra-high molecular weight polyethylene (UHMWPE) has been considered the most successful choice as a bearing material for tibial plates in total knee arthroplasty (TKA). However, considering that osteolysis by polyethylene wear debris is yet one of the most common reasons for TKA revision, improving wear and oxidation resistance of UHMWPE has historically been recognized as the key task for ensuring longer-term implant survivorship in vivo. Beta sterilization is a unique sterilization method of B. Braun Aesculap (Tuttlingen, Germany) and has the potential to reduce the generation of free radicals and to prevent oxidation, because the process is completed in short time. In this study, Raman spectroscopy has been used to compare the surface of unused and retrieved beta sterilized conventional tibial inserts in terms of variation of crystallinity and strain.
Subjects and Methods: We performed experiments on 9 retrieved and 3 unused tibial inserts made of beta sterilized conventional UHMWPE (GUR 1020, Columbus UC and PS, B. Braun Aesculap) with in-vivo time of average 26.2 months (0.7—74). For each samples, we analyzed 3 locations (medial load zone, non-load zone, lateral load zone) on the surface by means of a nondestructive spectroscopic method based on confocal Raman spectroscopy. Square maps of 50 $\times$ 50 μm, 11 $\times$ 11 Raman spectra were collected at different depths (0, 100, 1000 μm in-depth) in order to assess the crystallinity and strain. We calculated fractions of crystallinity using a method based on a set of equations that includes the intensities of vibrational bands located at 1296, 1305, and 1414 cm^{-1} as obtained from Raman spectra. In addition, the full-width at half maximum (FWHM) of the Raman band located at 1130 cm^{-1} was used as a deformation sensor to assess creep deformation in the medial and lateral load zones of patients with different body weight and implantation time.
Results: As compared to the unused samples, in all the retrievals the crystallinity increased in both load zones up to depth of 1000 μm and there was a strong correlation with in-vivo time ($p < 0.05$). Furthermore, in all the 9 investigated retrievals, FWHM showed clear broadening as compared to the unused samples in depth 100 μm. A linear correlation between increase of FWHM and body weight was found regardless of the in-vivo term, and such correlation was more precise in the lateral load zone than in the medial load zone (lateral load zone: spearman rho $= 0.866$, $p < 0.05$).
Discussion and Conclusion: In previous studies, we showed that increase of crystalline phase fraction is correlated to the oxidative degradation of polyethylene. In this study, it was observed that the crystallinity increased on all the retrieved samples as compared to the unused samples, which means that oxidative degradation occurred even in the case of sterilization by beta ray. It was reported that the amount of creep deformation is likely to vary among patients, which was confirmed by the correlation between FWHM and body weight reported in our study. Within data from the same patient, we noticed that the strain in the lateral load zone was greater than that in the medial load zone, which might be explained considering the influence of lift-off phenomenon related to the load on the lateral side.

http://dx.doi.org/10.1016/j.jot.2016.06.132

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SURGICAL RESULTS OF DEVELOPMENTAL DISLOCATION OF THE HIP IN OLDER CHILDREN BASED ON ASSISTANCE OF DIGITAL ORTHOPAEDICS

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Objective: The surgical treatment of developmental dislocation of the hip (DDH) in older children was difficult to resolve and was always the subject of controversy. The purpose of the study was to evaluate the correlation of the radiographics and clinical outcome in patients with neglected DDH who underwent individual procedures based on using digital orthopaedics method.
Methods: Pre-operative X-ray and 3D-CT were performed to evaluate the deformities of DDH accurately. According to the anatomical development situation of each patient's hip, Forty-three patients (67 hips) were treated using Pemberton osteotomy, Dega+Pemberton osteotomy or Bernese Osteotomy. Before Bernese operation, surgical guide plate made to assist osteotomy by rapid prototyping (RP) technique. Subtrochanteric transverse femoral shortening and derotation osteotomy were performed for all patients.
Results: The average age at the time of surgery was 9.5 years for Group I (bilateral dislocation, 28 hips) and 10.6 years for Group II (unilateral dislocation, 39 hips). Mean follow-up was 4.2 years for Group I and 5.6 years for Group II. At the end of follow-up, 14 hips were rated excellent, 8 hips were good, and 6 hips were fair in Group I. In Group II, 23 hips were rated excellent, 11 hips were rated good, and 5 hips were fair. There were 7 patients had a limb-length discrepancy of approximately 1.5 cm in Group II. Three hips in Group I and 4 hips in Group II had revision operation caused by dislocation or residual dysplasia of varying severity post-operatively.
Conclusion: It is necessary to evaluate the radiographics pathological findings and to make personalized osteotomy plans pre-operatively. All experience especially on digital orthopaedics methods surrounding the surgical procedure, are the main reasons for the satisfactory therapeutic effects achieved in this study in older children with DDH.
*XZ and QDL contributed equally to this work as co-first authors.

http://dx.doi.org/10.1016/j.jot.2016.06.133

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STAIR CLIMBING KINEMATICS MEASURED IN THE GAIT LAB AS INPUT FOR TOTAL KNEE WEAR TESTING

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Objective: An important tool for preclinical testing of total knee replacement (TKR) is wear simulation. The American Society for Testing and Materials has initiated a workgroup to evaluate how multiple activities may be incorporated into a new wear testing standard for TKRs (ASTM WK31128). Among other activities, recommendations for standardized testing waveforms include stair climbing. The pur-